

EXHIBIT A

0020682

DISCLOSURE: Integrated Closed Loop Control Principle for Combined UPS and Generator System

September 9, 2000

PATENTS

OCT 12 2000

TO: Manager, Patents & Licensing, EPRI

FROM: Steven Eckroad

SUBJECT: DISCLOSURE OF DISCOVERY

In accordance with the EPRI discovery policy, I hereby disclose to the Institute the Discovery described in the succeeding paragraphs of this memorandum of disclosure and in any attachment hereto.

1. Title of Discovery:

Integrated Closed Loop Control Principle for Combined UPS and Generator System

2. Identification of inventors:

- a. Name:
 - 1. Steven Eckroad
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 - 4. Germany

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Robert B. Schenck 9/27/00
(Signature of witness) (Date of signature)

3. Documentation:

- a. Citation to prior written description of Discovery: None
- b. Relation to prior disclosures: None.
- c. Patents or publications related to Discovery: None.

4. Relation to Programs of EPRI:

- a. Program name: Substations Asset Utilization Target, Power Delivery Sector
- b. Program number: Target No. 027550
- c. Program manager: Ray Lings
- d. Related projects: UPS SubstationTM, Product No. WO4481

5. Significant Dates

- a. Conception: January 2000
- b. Reduction to practice: Simulation results March 2000
- c. Disclosure to others: None

6. The Description of the Discovery:

a. Title of Invention:

Integrated Closed Loop Control Principle for Combined UPS and Generator System

b. Background of the Invention:

The field of the Invention relates to the improvement of power quality and reliability for sensitive electrical loads through the generation, stabilization and control of electric power. In particular, the field of the Invention relates to an uninterruptible power supply (UPS). A state-of-the-art UPS nominally consists of a self-commutated, static inverter (or rectifier/inverter) together with some form of electrical energy storage. In addition to the UPS, which compensates for short term voltage disturbances and power interruptions, an engine-driven electrical generator ("gen set") may also be connected to the customer's load bus for handling longer term interruptions.

There are a number of different devices that are utilized in the current state of the art for the improvement of power quality and reliability. There are three devices that specifically relate to the field of the Invention: static compensator (STATCOM), on-line UPS, and off-line UPS. These are briefly described below.

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STATCOM

A STATCOM consists of a Voltage Source Converter (VSC) connected to the AC system through a shunt-connected transformer. A capacitor is connected to the DC side of the VSC. This element controls the voltage by injecting or absorbing reactive power.

Features:

- Effectively controls load voltage fluctuations that result from the load's transient or changing reactive power requirements
- Relatively low operation costs
- No active power available and therefore no operation under short circuit conditions possible.
- Limited ability to correct voltage fluctuations due to grid faults or switching events

On-line UPS

Figure 1 illustrates the main components of an on-line UPS.

- The system is on-line during normal operation. On-line means: Convert energy via the rectifier from AC to DC, maintain the battery at full charge, and convert the energy via the inverter to an AC-system (double conversion). The static switch and the mechanical bypass are open.
- The UPS operates synchronized with the bypass source or with the grid
- A chemical battery is used as energy storage for bridging outages
- In case of malfunction of the system the mechanical switch allows operation by connecting the grid or bypass supply directly to the load.
- In case of a malfunction on the load assembly, the static bypass switch is closed to increase short circuit capability for fuse coordination.
- In case of a malfunction on the grid, the rectifier is blocked and energy is taken from the battery without disturbances on the load.

Features:

- Double conversion with relatively high operation costs
- The grid is decoupled from the load. No transients on the load voltage under grid disturbances.
- Short circuit capability provided by closing the static bypass.

Off-line UPS

Figure 2 illustrates the main components of an off-line UPS.

- The system is off-line during normal operation. Off-line means: The static switch is closed, the mechanical bypass is open, and the converter maintains the battery at full charge.
- A chemical battery is used as energy storage for bridging outages

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- Outage and sag conditions on the grid must be detected fast in order to protect the load.
- In case of a malfunction on the load assembly, the static bypass switch remains closed to make use of the grid short circuit capability for fuse coordination.
- In case of malfunction of the system the mechanical switch allows operation by connecting the grid directly to the load.
- In case of a malfunction on the grid the SSB will be opened and the converter supplies the load.

Features:

- Relatively low operation costs
- The grid is coupled to the load. Grid disturbances are transferred to the load under Stand By conditions (normal operation) until the static switch opens..
- Short circuit capability provided by the grid. (Intelligent measurement system has to detect on which side of the connection point the fault is)

The Invention is based on a state of the art off-line UPS, but enables performance features characteristic of both a STATCOM and an on-line UPS.

The goal for a UPS-System is to provide power to power sensitive loads such as a semiconductor manufacturing plant even under voltage disturbances and interruptions on the grid side. When a voltage disturbance is sensed in the grid the UPS control circuitry creates a complete disconnect from the grid and provides full ramp up of back up power to the load.

The Off-line UPS consists of a self-commutated static converter and an energy storage device. Different storage types (i.e., SMES, battery, and ultra-capacitor) are possible candidates for an UPS system. Dependent on the electrical behavior of the storage device a suitable interface to the converter has to be chosen. On the one hand the static converter provides an excellent dynamic behavior and on the other hand the converter power semiconductor have more or less no overload capability.

For long term interruptions separate power generation is needed. For this purpose an independent gen set is connected directly to the load side of the AC-system. A state of the art gen set consists of a power source (i.e. a diesel or gas engine) and a mechanical to electrical conversion device (i.e. a generator) (Figure 3).

The accompanying control system controls the torque and the speed of the shaft (the product of which equals the active power). The shaft speed corresponds to the electrical system frequency. The amplitude of the system voltage can be controlled via the excitation of the synchronous generator. Typically, the gen set has a long response time to dynamic variations and a large overload capability. The reason for the long response

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time is the electro-mechanical and the power generation process with its rotating mass. System resonance frequencies in the area of a few Hertz are usual.

In the following discussion an UPS with an added gen set is referred to as a UPS-System (see Figure 4).

Each component of the UPS-System, the gen set as well as the UPS, has its own closed loop control unit. An overlaid sequence control communicates with both control systems and generates commands for each of them. The state of the art operation principle operates the two independent devices in the following way:

- Stand By Mode: gen set is not in operation; UPS is in Stand-By mode (monitoring the grid voltage, providing reactive power, and absorbing active power to cover the losses); the switch is closed.
- Disturbance on the grid side: Initiate the switch to open; load take over by the UPS (island mode); dependent on the energy content of the storage device initiate the gen set to start;
- Short term interruption ends: Resynchronize island system to the utility; initiate the switch to close; load hand over to the utility; charge the storage device; transfer back into Stand By mode; gen set is not in operation.
- Long term interruption: Transfer from the UPS to the gen set; UPS system remains in Stand By mode or in Charge mode; switch is open.
- Long term interruption ends: Resynchronize island system to the utility; initiate the switch to close; Load transfer to the utility.

In the case of a long term operation the gen set provides the active power to the load. The UPS-System operates in Stand By or Charge mode. The drawback of this operation principle is that the good dynamic behavior of the UPS (i.e., rapid response to reactive or active power variations in the load and stabilization of frequency) can not be used because there is no common control unit available.

c. Summary of the Invention

The Invention optimizes the state-of-the-art UPS-System by means of an integrated control system. System optimization is achieved in both component choice (i.e., hardware) and operation. In particular, the Invention makes it possible to fully utilize a VSC for the static converter component. Further, with a VSC deployed the Invention enables the gen set and the UPS to simultaneously control the load voltage by injecting or absorbing active and reactive power.

[Explanation: In the case of a long term interruption the gen set supplies the power to the load. During this period, the UPS operates in Stand By mode, unless recharging the Storage. So both systems (the UPS as well as the gen set) are in operation, but can not

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simultaneously serve the load. The overall system can be optimized if the control system of the UPS System and the control system of the gen set are integrated into one closed loop control (functionally one unit).]

Thus, the Invention results in improved performance over a state-of-the-art UPS-System, including:

1. Operation of the UPS as a STATCOM to respond to the load's reactive power requirements.
 2. Dynamic load leveling by providing or absorbing active power with the UPS System.
 3. Optimized dynamic behavior under island conditions
 4. Optimized behavior during hand over between UPS and gen set
- d. Brief Description of the Drawings

Figure 1: On-line UPS Block Diagram

Figure 2: Off-line UPS Block Diagram

Figure 3: Basic Components of a Gen Set

Figure 4: Single Line Diagram of State-of-the-art Off-line UPS System

Figure 5: Overview of the Integrated Control Unit (the Invention)

Table 1: Traced Values in the Simulations

Figure 6: Simplified Single-line Diagram of the Simulation Set Up.

Figure 7: Timing Overview for the Simulations

Figure E-1: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $pf = 0.7$, Motor-Load 1 MVA, $pf = 0.87$, symmetrical voltage sag of 0.6 pu, begin of sag

Figure E-2: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $pf = 0.7$, Motor-Load 1 MVA, $pf = 0.87$, symmetrical voltage sag of 0.6 pu begin of sag

Figure E-3: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $pf = 0.7$, Motor-Load 1 MVA, $pf = 0.87$, symmetrical voltage sag of 0.6 pu, begin of sag

Figure E-4: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $pf = 0.7$, Motor-Load 1 MVA, $pf = 0.87$, symmetrical voltage sag of 0.6 pu, begin of sag

Figure E-5: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $pf = 0.7$, Motor-Load 1 MVA, $pf = 0.87$, symmetrical voltage sag of 0.6 pu, Take over of Load by Genset

Figure E-6: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $pf = 0.7$, Motor-Load 1 MVA, $pf = 0.87$, symmetrical voltage sag of 0.6 pu, Take over of Load by Genset

Figure E-7: Battery Energy storage and Genset at AC, symmetrical voltage sag of 0.6 pu, Take over of Load by Genset

Figure E-8: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $pf = 0.7$, Motor-

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Load 1 MVA, $\text{pf} = 0.87$, symmetrical voltage sag of 0.6 pu, Take over of Load by Genset

Figure E-9: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $\text{pf} = 0.7$, Motor-Load 1 MVA, $\text{pf} = 0.87$, symmetrical voltage sag of 0.6 pu, Switch off and on of RL-Load

Figure E-10: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $\text{pf} = 0.7$, Motor-Load 1 MVA, $\text{pf} = 0.87$, symmetrical voltage sag of 0.6 pu, Switch off and on of RL-Load

Figure E-11 Battery Energy storage and Genset at AC, RL-Load 5 MVA, $\text{pf} = 0.7$, Motor-Load 1 MVA, $\text{pf} = 0.87$, symmetrical voltage sag of 0.6 pu, Switch off and on of RL-Load

Figure E-12: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $\text{pf} = 0.7$, Motor-Load 1 MVA, $\text{pf} = 0.87$, symmetrical voltage sag of 0.6 pu, Switch off and on of RL-Load

Figure E-13: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $\text{pf} = 0.7$, Motor-Load 1 MVA, $\text{pf} = 0.87$, symmetrical voltage sag of 0.6 pu, Switch off and on of RL-Load

Figure E-14: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $\text{pf} = 0.7$, Motor-Load 1 MVA, $\text{pf} = 0.87$, symmetrical voltage sag of 0.6 pu, Switch off and on of RL-Load

Figure E-15: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $\text{pf} = 0.7$, Motor-Load 1 MVA, $\text{pf} = 0.87$, symmetrical voltage sag of 0.6 pu, Switch off and on of RL-Load

Figure E-16: Battery Energy storage and Genset at AC, RL-Load 5 MVA, $\text{pf} = 0.7$, Motor-Load 1 MVA, $\text{pf} = 0.87$, symmetrical voltage sag of 0.6 pu, Switch off and on of RL-Load

e. Detailed Description of the Invention

The integrated closed loop control (the Invention) operates the static converter and the gen set in different modes as described below (see Figure 5 – values with an asterisk are reference values, and values without an asterisk are actual values). Note that either the (converter) current controller or voltage controller is activated at any given time. The current controller is active in standby mode, charge mode and discharge mode with diesel gen set. The voltage controller is only active in discharge mode without gen set.

UPS Stand-By Mode

During Stand-by operation mode, the energy storage system connected is just maintained at full charge. The converter maintains system voltage at an optimum level with reactive power generation or absorption and a small amount of active power to compensate for the losses of the attached energy storage system.

In Stand-by mode Statcom operation is available via the Q controller that controls the amplitude of the load voltage, VLabs. The output of the Q-controller generates the

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reference value of converter reactive current IB^* and is connected to the converter current controller. IB is the reactive converter current (proportional to converter reactive power).

The DC-link voltage controller controls the DC-link voltage, VDC . The output of the DC-link voltage controller is connected to the storage control unit. The storage control unit generates (with the output of the DC link controller) the setpoint, IW^* , for the converter current controller. (The output of the Load Sharing control is zero during Stand-By.) IW is the active current of the converter (proportional to Converter active power).

The outputs of the converter current controller and converter voltage controller are connected to the pulse pattern generation unit. The pulse pattern generation unit triggers the drive circuits of the power semiconductor.

UPS Charge Mode

The charge mode is identical to the Stand By mode with one exception. The exception is that the storage control unit generates a setpoint, IW^* , for the converter current controller to charge the storage.

UPS Discharge Mode

After the Sag and Outage Detection unit has opened the switch in case of a grid fault the converter takes over the full load. The storage control unit and the converter current controller are disabled. The converter voltage controller is enabled. The control strategy has changed from a current or power control mode to a voltage control mode. The reason for this is that under island conditions a power control is not possible. Under island conditions only the load defines the reactive and active power. Both reactive and active power are supplied by VSC and Storage. Applying reactive and active power via the VSC significantly reduces frequency variations due to load switching.

Gen Set Start Up

The mode selection unit starts the gen set and the gen set speed ramps up, while the VSC and Storage supplies the load. The gen set speed n is controlled by the gen set control system. The fuel injection system determines the torque of the gen set. The amplitude of the generator output voltage, V_{genabs} , is controlled by the Generator Excitation Control. When the generator output voltage has been synchronized to the load voltage, VL , the generator switch will be closed. In order to gain an optimized (smooth or pumpless) takeover from discharge mode without diesel gen set into diesel gen set forming the primary power source, the load sharing controller ramps the active power output down as the gen set ramps up.

Parallel Operation Gen Set and UPS

If the generator switch has been closed the converter current controller and Q-control are re-enabled. The converter-voltage controller is disabled. The load voltage is determined

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by the generator with active assistance from the VSC and Storage. The active and reactive power of the static converter are controlled via its current controller. The load-sharing controller (Figure 5) controls the load sharing between the UPS and the gen set.

The converter current controller slowly ramps the converter active power down as the gen set takes over the load. Under steady state conditions the UPS provides no active power. The VSC provides reactive power to the system as required (Statcom function). With the STATCOM function operational stability of the load voltage can be improved.

Under steady state conditions the gen set provides the active power for the load. Under dynamic conditions, due to the relatively slow speed control of an electro mechanical system in combination with the power generation process, the speed of the system varies in a wide range. Therefore, dynamic frequency variations occur. The UPS with its short response time is able to minimize frequency fluctuations by injecting or absorbing active power. Due to the limited storage the UPS must control the average amount of active power to zero.

Transfer to the Utility

After system (grid) voltage has returned the gen set is synchronized to the system (grid) voltage, VN. If the load voltage, VL, is synchronized to the grid voltage, VN, the Sag & Outage Detection unit opens the switch. The mode selection unit in combination with the reference value generator ramps down fuel injection, the grid takes over the load and generator switch is opened.

Comparison With and Without the Control Strategy (the Invention)

An analysis of system behavior with the Invention was carried out with computer simulations, to validate the claims for the Invention. An example of the behavior is done with a Diesel gen set, and a UPS system consisting of a VSC and a battery energy storage system for short term interruptions (Figure 6). The following discussion and accompanying figures show the behavior under an extended 3-phase sag. The following transition events are shown: beginning of sag; transfer to Gen-set; load rejection and return during UPS island operation; and grid return with synchronized transfer from island source to grid.

Load for simulations: Combined RL (5 MVA, PF 0.7) and Motor (1 MVA, PF 0.87)

The timing diagram in Figure 7 describes the sequence of events simulated to verify the application and performance of the Invention.

Event: Symmetrical Voltage sag down to 0.4 pu (Grid voltage sags by 60%); beginning of Sag at t1.

Figure E-1: Grid voltage (3 Ph.), load voltage (3 Ph.) and the amplitude of both.

Figure E-2: Grid current (3 Ph.), load current (3 Ph.), the Converter currents (3 Ph.), and gen set currents (3 Ph.).

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Figure E-3: DC-link voltage, DC-link currents, Converter active and reactive power, motor load active and reactive power

Figure E-4: Generator electrical and mechanical torque, and generator speed

Findings: Almost immediately the sag and outage detection has commanded disconnection of the load from the grid, by triggering the Solid State Breaker. Approximately 6 ms later UPS has built up load voltage and forms the island source to the load. The load voltage stabilizes immediately to 0.95 pu. Some power exchange is shown between the squirrel cage type motors and the island source.

Event: Gen set takes over load from UPS storage system at t2 after the generator voltage has been synchronized to the load voltage and the generator switch has been closed. The synchronizing needs a few seconds due to the time constants of the power generation process and is not simulated.

Figure E-5: Grid voltage (3 Ph.), load voltage (3 Ph.) and the amplitude of both.

Figure E-6: Grid current (3 Ph.), load current (3 Ph.), the Converter currents (3 Ph.), and gen set currents (3 Ph.).

Figure E-7: DC-link voltage, DC-link currents, Converter active and reactive power, and motor load active and reactive power

Figure E-8: Generator electrical and mechanical torque, and generator speed

Findings: The converter forces the load current to the gen set after the generator switch has been closed. The excitation controller (governor) of the generator controls the load voltage. The load voltage decreases to nearly 85 % and the excitation controller needs approx. 150 ms to lift the load voltage. It is possible to activate the Statcom function of the Converter to mitigate this voltage decrease (for demonstration purposes not activated in this case). The speed of the gen set generator decreases to 97.5 %. The mitigation of this speed decrease is performed via gen-set speed control (not shown in the chosen time scale).

Event: Load rejection (5 MVA RL-load) at t3 for almost 150 ms during the sag conditions, with load return. Two possibilities of control are shown:

A. Converter provides reactive power only (Statcom Operation):

Figure E-9: Grid voltage (3 Ph.), load voltage (3 Ph.) and the amplitude of both.

Figure E-10: Grid current (3 Ph.), load current (3 Ph.), the Converter currents (3 Ph.), and gen set currents (3 Ph.).

Figure E-11: DC-link voltage, DC-link currents, Converter active and reactive power, and motor load active and reactive power

Figure E-12: Generator electrical and mechanical torque, and generator speed

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B. Converter injects / absorbs active and reactive power (Load Sharing):

Figure E-13: Grid voltage (3 Ph.), load voltage (3 Ph.) and the amplitude of both.

Figure E-14: Grid current (3 Ph.), load current (3 Ph.), the Converter currents (3 Ph.), and gen set currents (3 Ph.).

Figure E-15: DC-link voltage, DC-link currents, Converter active and reactive power, motor load active and reactive power

Figure E-16: Generator electrical and mechanical torque, and generator speed

Findings: Dynamic system performance is acceptable in case a. The impact of reactive power of Converter (Statcom operation) reduces over-voltage at load rejection and increases sagged voltage resulting from load return by almost 50%. Settling time to obtain nominal load voltage takes about 30 to 50 msec. Except for some transients no storage charging or discharging happens. Due to the fact that the generator is of the synchronous type, it directly influences the island system frequency. Therefore, to minimize frequency excursions, it is desirable to operate the UPS-System as suggested in Case B. In both cases, the generator speed variation is reduced by a factor of 2 under the simulated conditions.

Claims:

1. Control strategy for the combination Off-line UPS (self-commutated converter plus storage) and gen set.
 - Under point 1, load sharing control between both components (Off-line UPS and gen set) under island conditions. (separate claim)
 - Under point 1, load stabilization under transfer of load from off-line UPS to gen set.
 - Under point 1, load stabilization under transfer of load from gen set back to the utility grid
2. Control strategy (dual control mode) for the UPS system: Change from current control (second power source available) to voltage control (island mode: UPS is single source) and back to current control (island mode: UPS plus gen set)
3. Claim under point 1 with a battery storage system (Further claims with other storage types)
4. Claim under point 1 with a voltage source converter
5. Control Strategy for combining continuous operation of a static compensator device (STATCOM & Storage) with simultaneous operation of a gen set.
 - Under point 5, efficient load sharing between UPS and gen set such that each supplies the load requirements for which it is best suited (UPS: reactive power, rapid response to load and frequency variations; gen set: short circuit overload capability for fuse coordination and continuous power)
 - Under point 5, efficient maintaining of the storage system charge state.

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f. Drawings

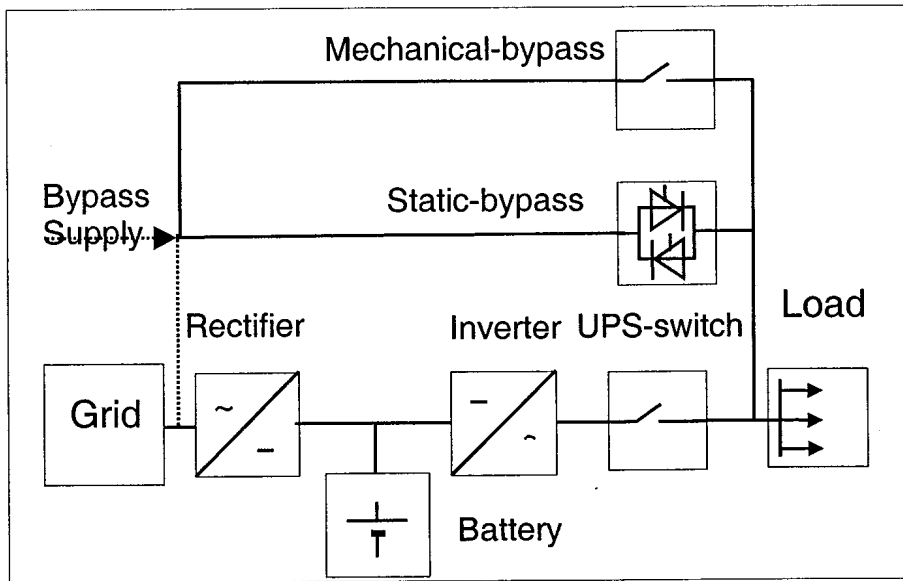


Figure 1: On-line UPS Block Diagram

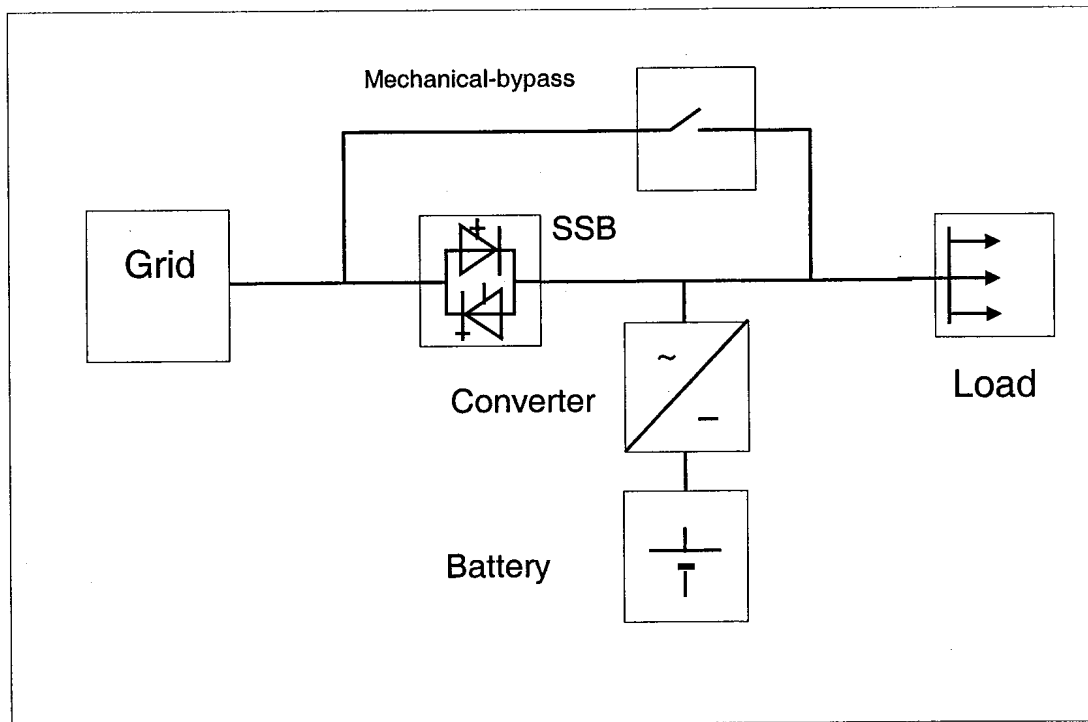


Figure 2: Off-line UPS Block Diagram

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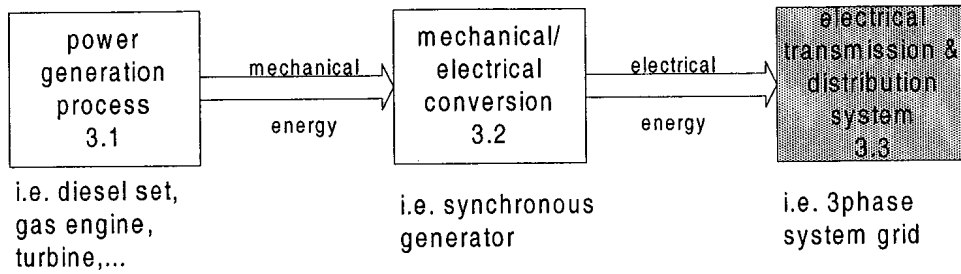


Figure 3: Basic Components of a Gen Set

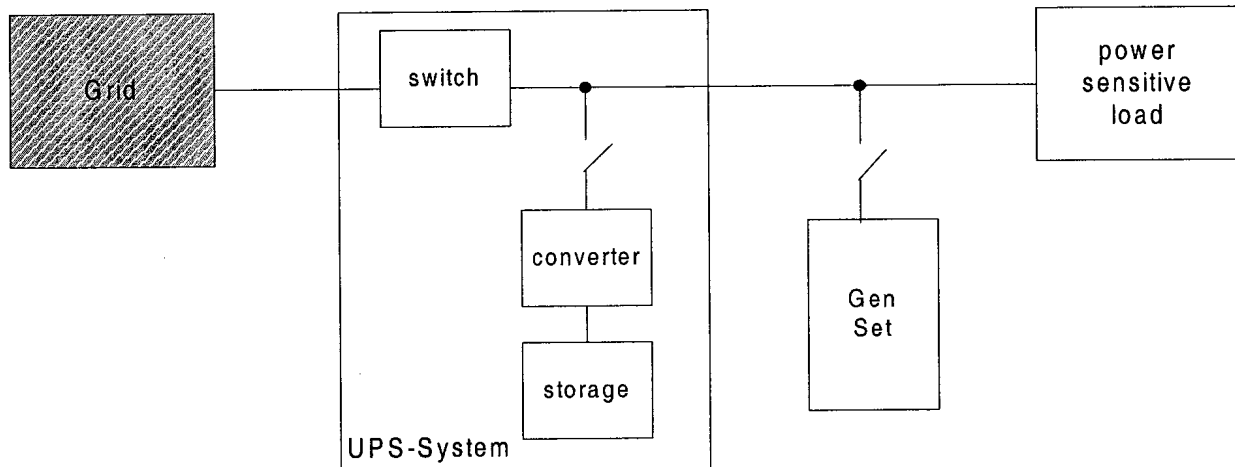


Figure 4: Single Line Diagram of State-of-the-art Off-line UPS System

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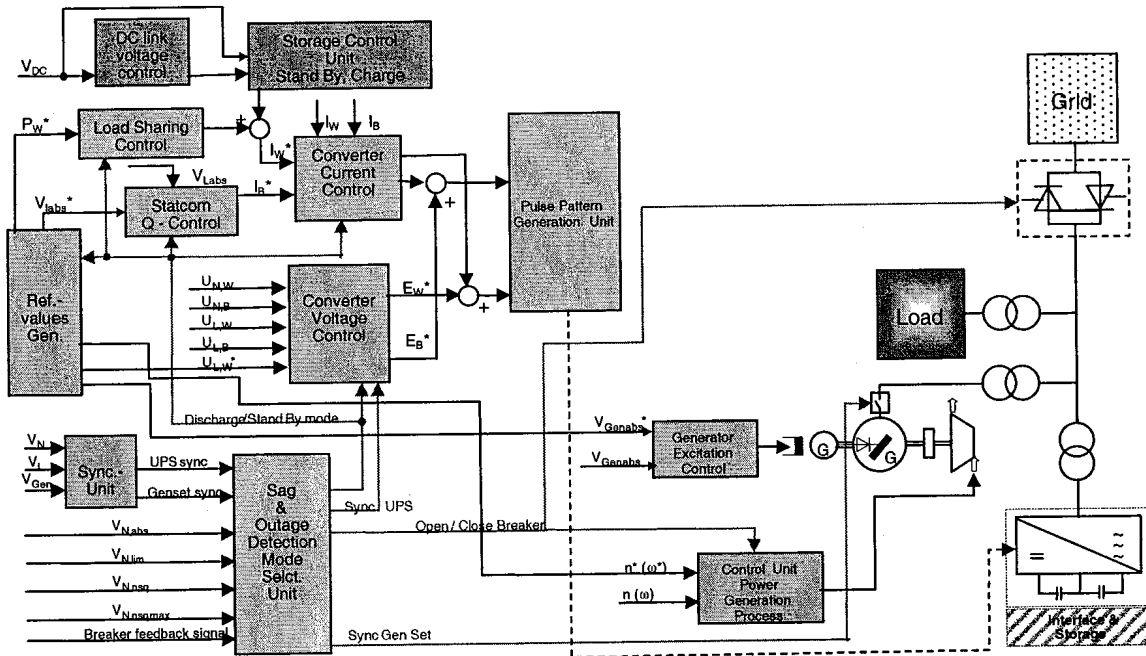


Figure 5: Overview of the Integrated Control Unit (the Invention)

Table 1: Traced Values in the Simulations

Grid		
Grid voltages (line to ground) on 13.8 kV level:	Van, Vbn, Vcn	[kV]
Grid currents on 13.8 kV level:	Ian, Ibn, Icn	[kA]
Amplitude of grid voltage:	Vabsn	[pu]
Phase of grid voltage:	Phabsn	[deg]
Load		
Load voltage (line to ground) on 13.8 kV level:	Val, Vbl, Vcl	[kV]
Load currents on 13.8 kV level:	Ial, Ibl, Icl	[kA]
Amplitude of load voltage:	Vabsn	[pu]
Phase of load voltage:	Phabsn	[deg]
Motor active power:	Pmot	[pu]
Motor reactive power:	Qmot	[pu]
Motor speed:	Wmot	[pu]

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Voltage Source Converter		
Converter currents on 13.8 kV level:	I_a, I_b, I_c	[kA]
Converter active power:	P	[MW]
Converter reactive power:	Q	[Mvar]
DC-link voltages:	V_{dc1}, V_{dc2}	[kV]
Gen Set		
Generator output currents (13.8 kV level):	I_{aG}, I_{bG}, I_{cG}	[kA]
Generator electrical torque:	T_e	[pu]
Generator mechanical torque (= torque of Diesel):	T_m	[pu]
Diesel / Generator speed:	WG	[pu]

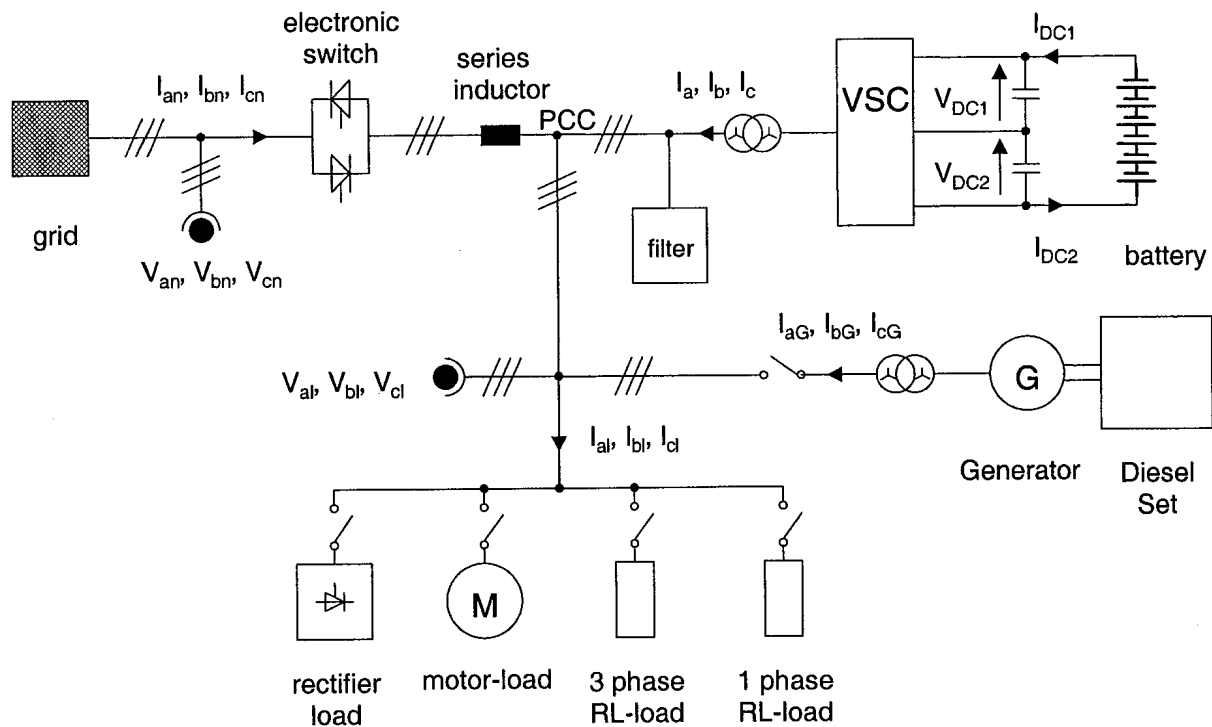


Figure 6: Simplified Single-line Diagram of the Simulation Set Up.

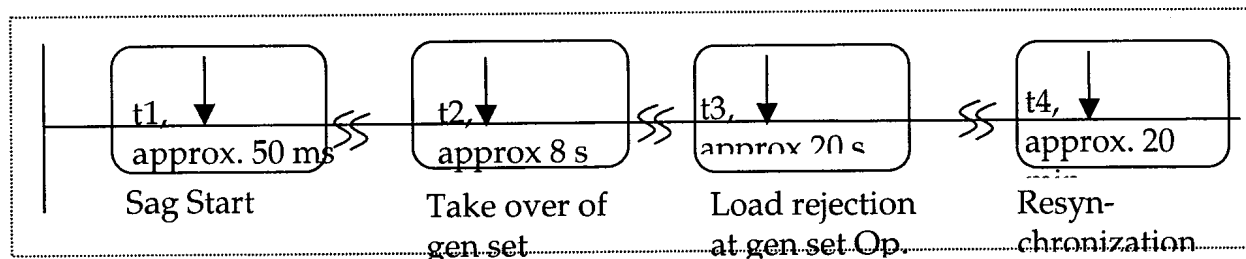


Figure 7: Timing Overview for the Simulations

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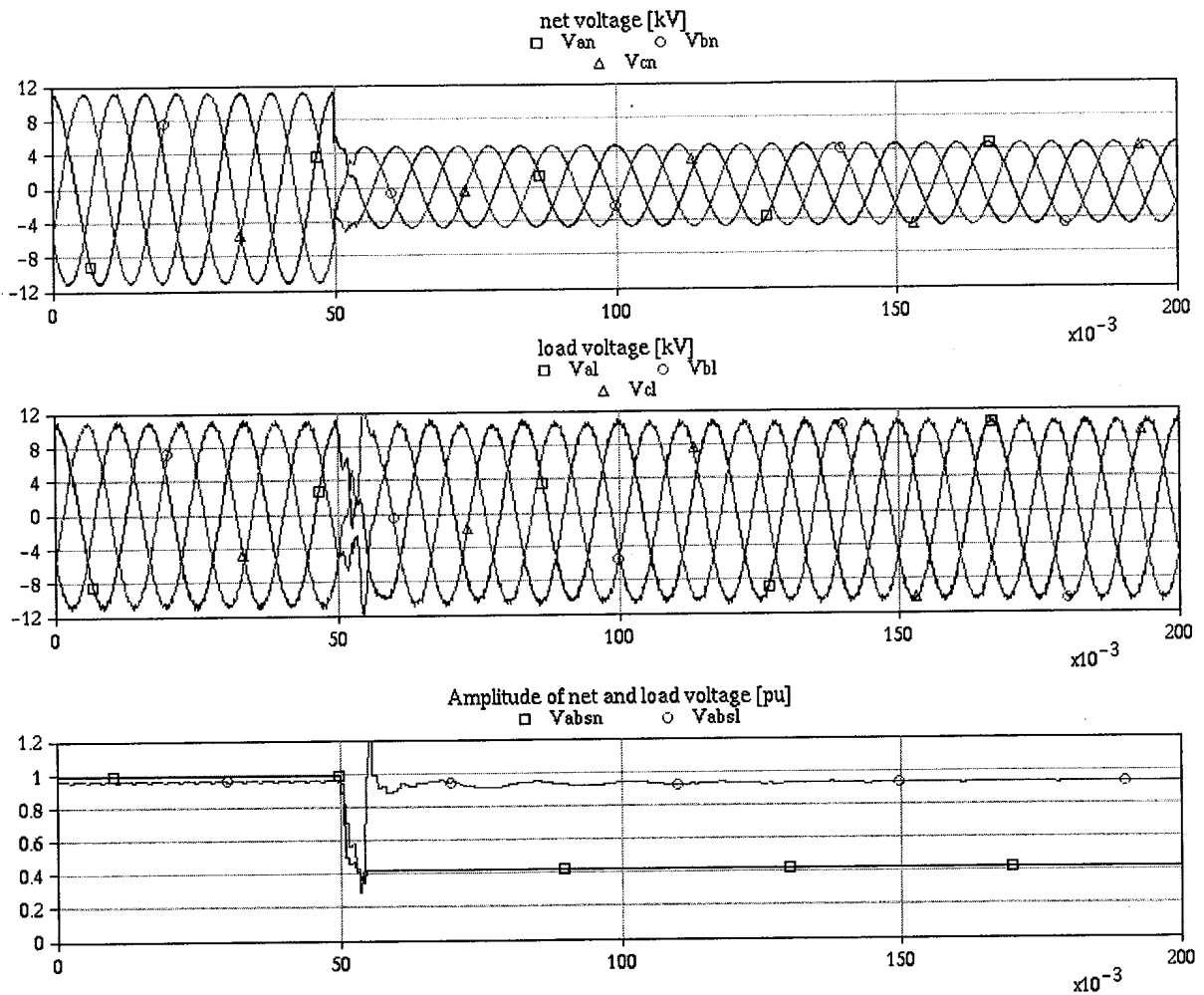


Figure E-1
RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
symmetrical voltage sag of 0.6 pu,
begin of sag

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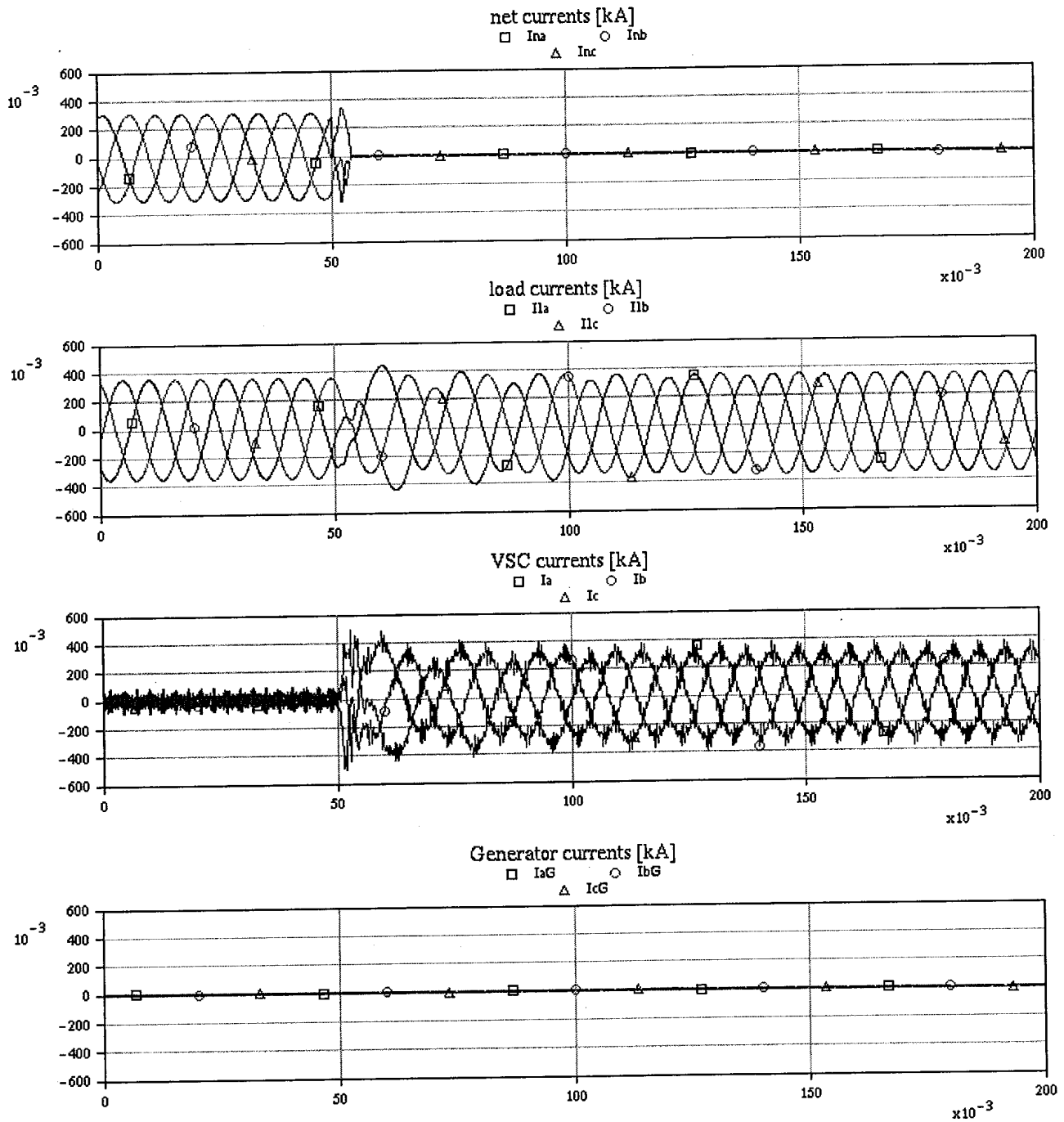


Figure E-2
 RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
 symmetrical voltage sag of 0.6 pu
 begin of sag

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Robert B. Scherle 9/27/00
 (Signature of witness) (Date of signature)

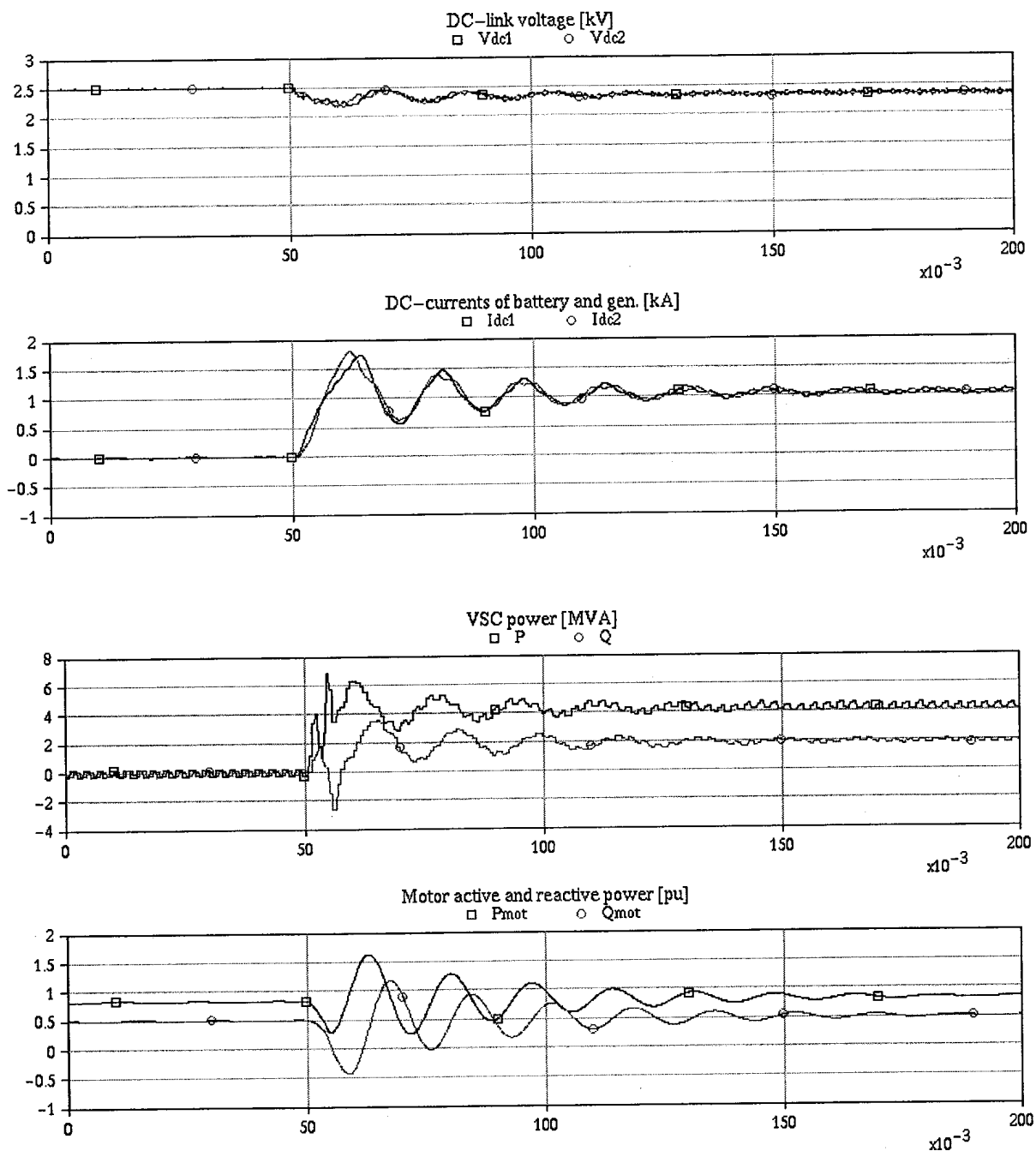


Figure E-3
 RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
 symmetrical voltage sag of 0.6 pu,
 begin of sag

This disclosure was read and understood by me on (date),
Robert B. Khoshdel 9/27/00
 (Signature of witness) (Date of signature)

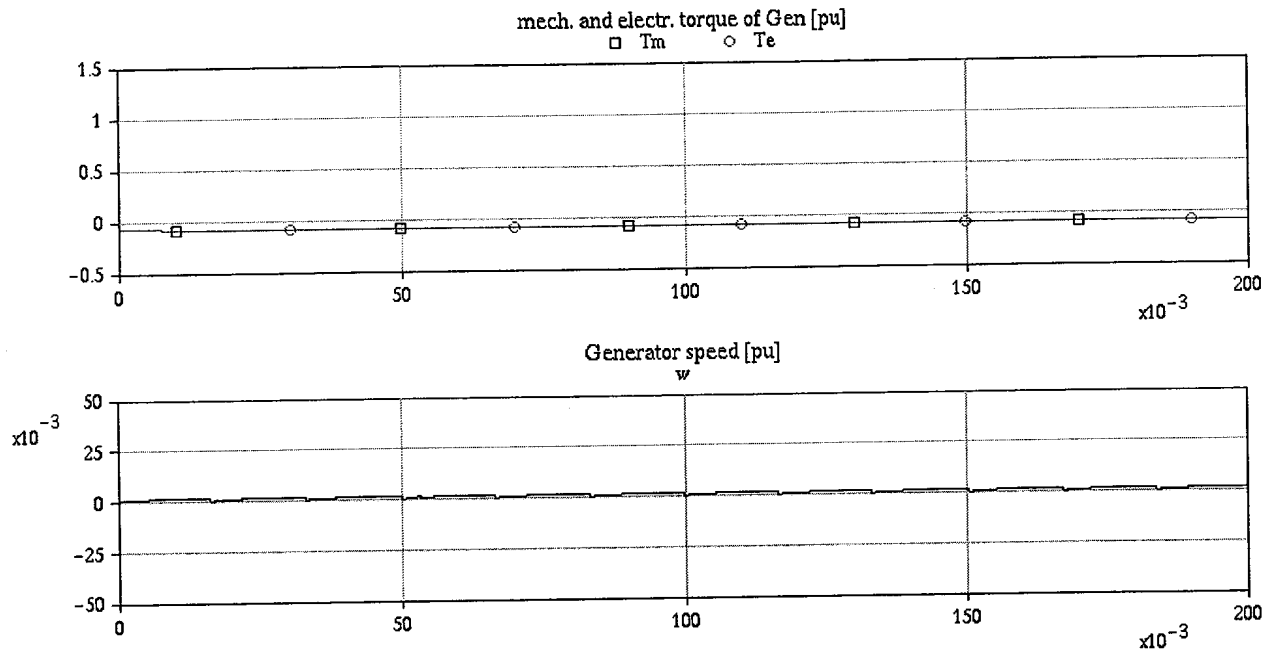


Figure E-4
RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
symmetrical voltage sag of 0.6 pu,
begin of sag

This disclosure was read and understood by me on (date).
Robert B. Schenk 8/27/00
 (Signature of witness) (Date of signature)

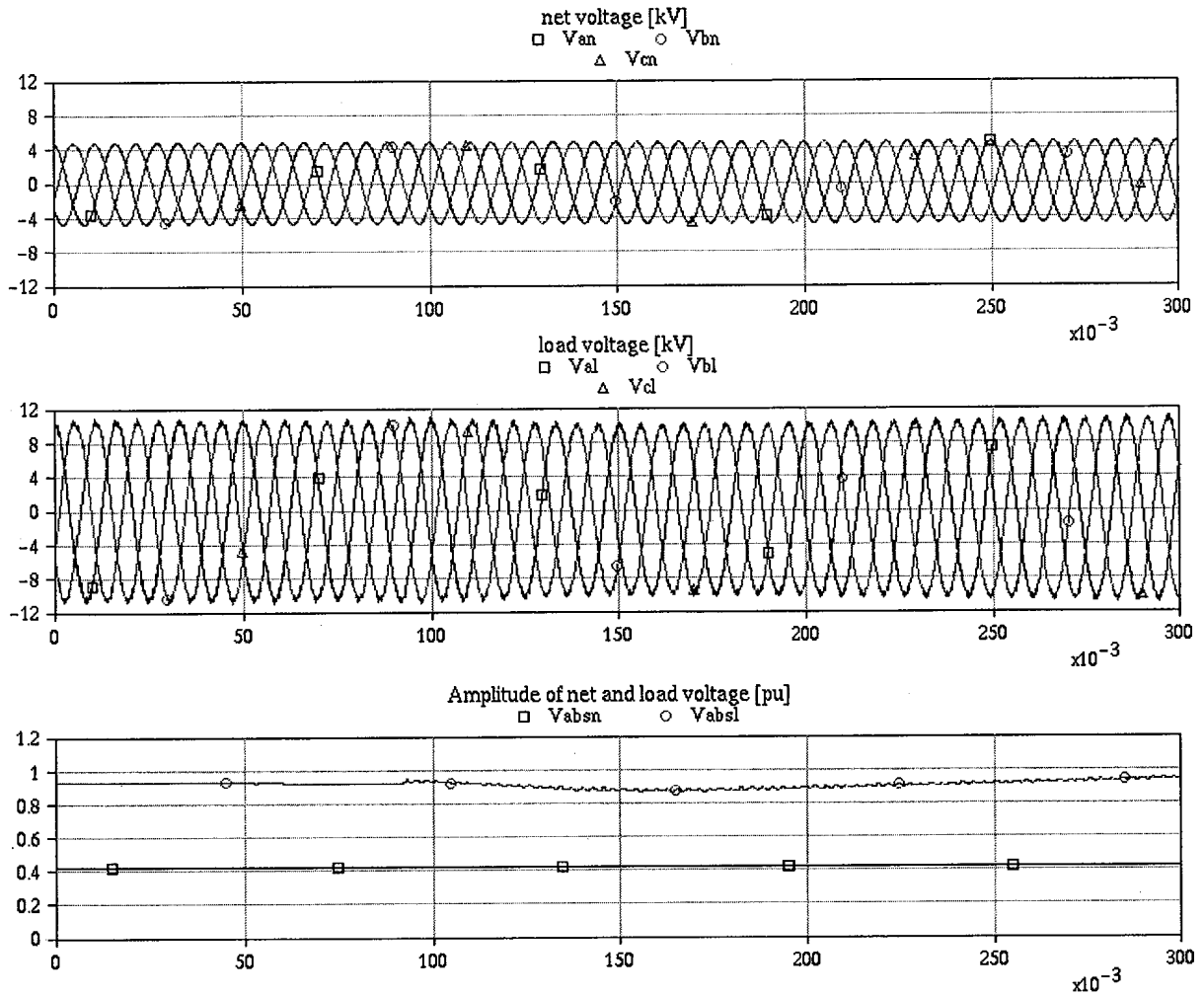


Figure E-5
RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
symmetrical voltage sag of 0.6 pu,
Take over of Load by Genset

This disclosure was read and understood by me on (date). 9/27/00
Robert B. Akbar
 (Signature of witness) (Date of signature)

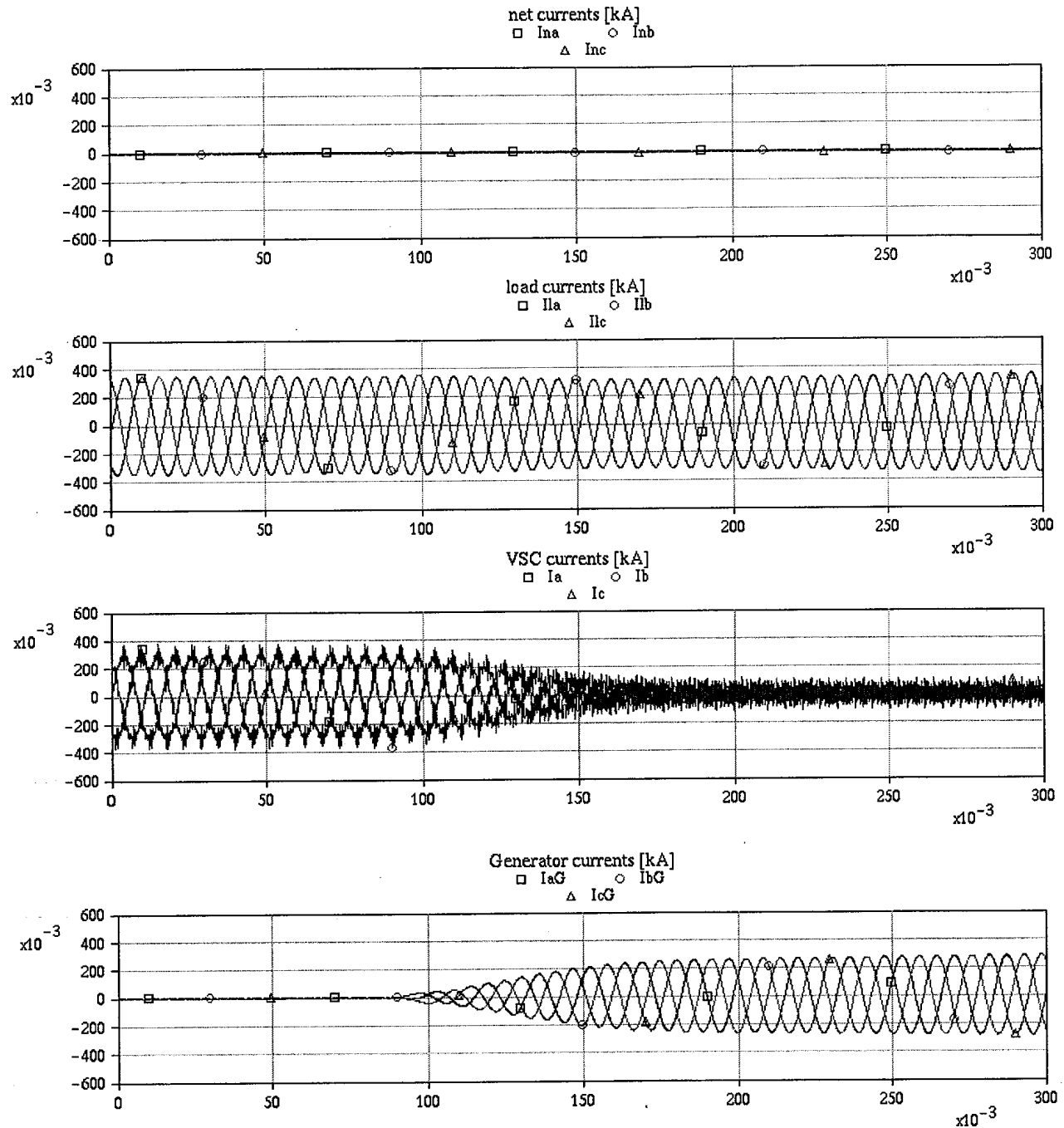


Figure E-6
 RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
 symmetrical voltage sag of 0.6 pu,
 Take over of Load by Genset

This disclosure was read and understood by me on (date) 9/27/00
Robert B. Schmitt
 (Signature of witness) (Date of signature)

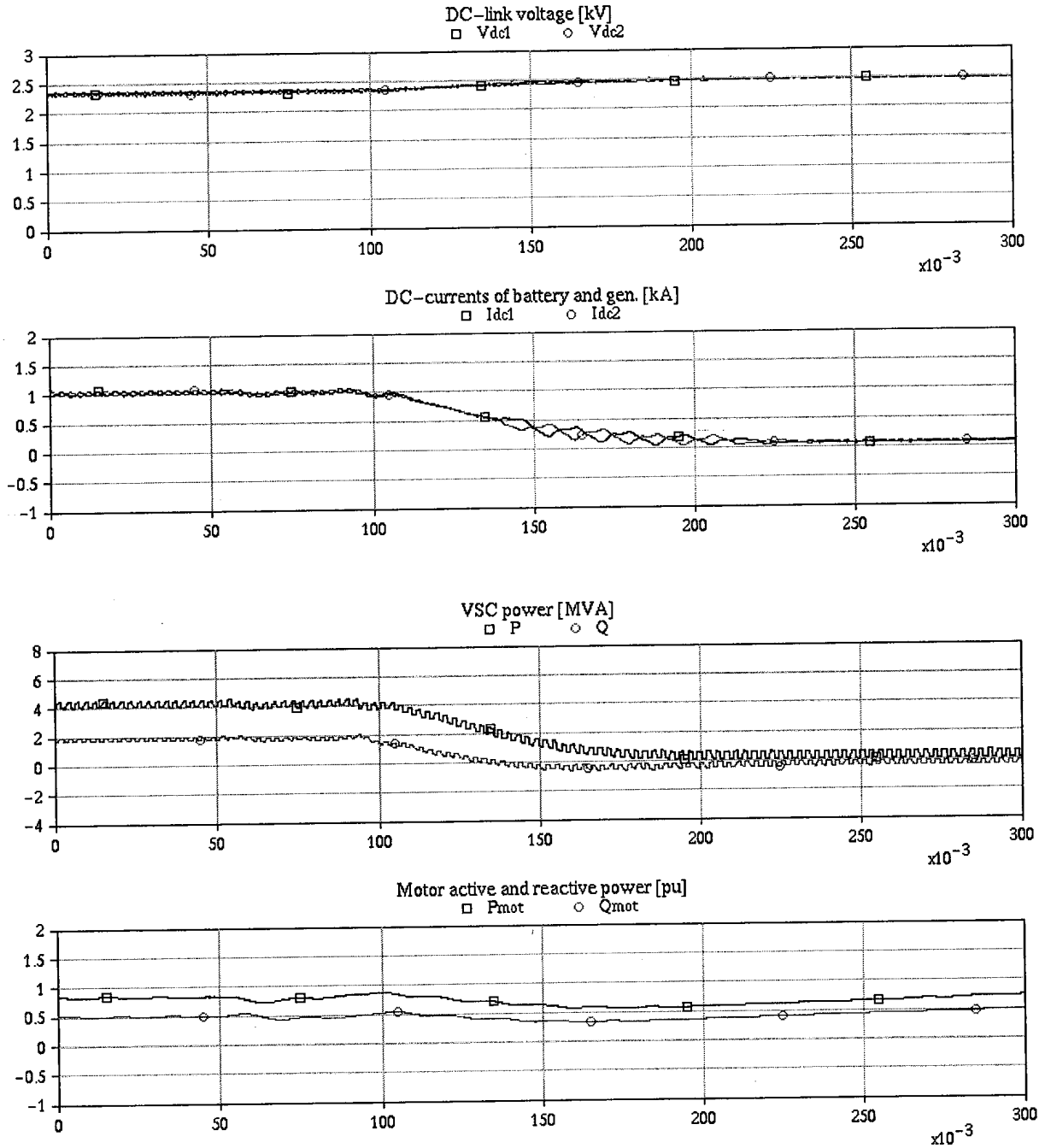


Figure E-7
symmetrical voltage sag of 0.6 pu,
Take over of Load by Genset

This disclosure was read and understood by me on (date).
Robert B. Nohrke 9/27/00
 (Signature of witness) (Date of signature)

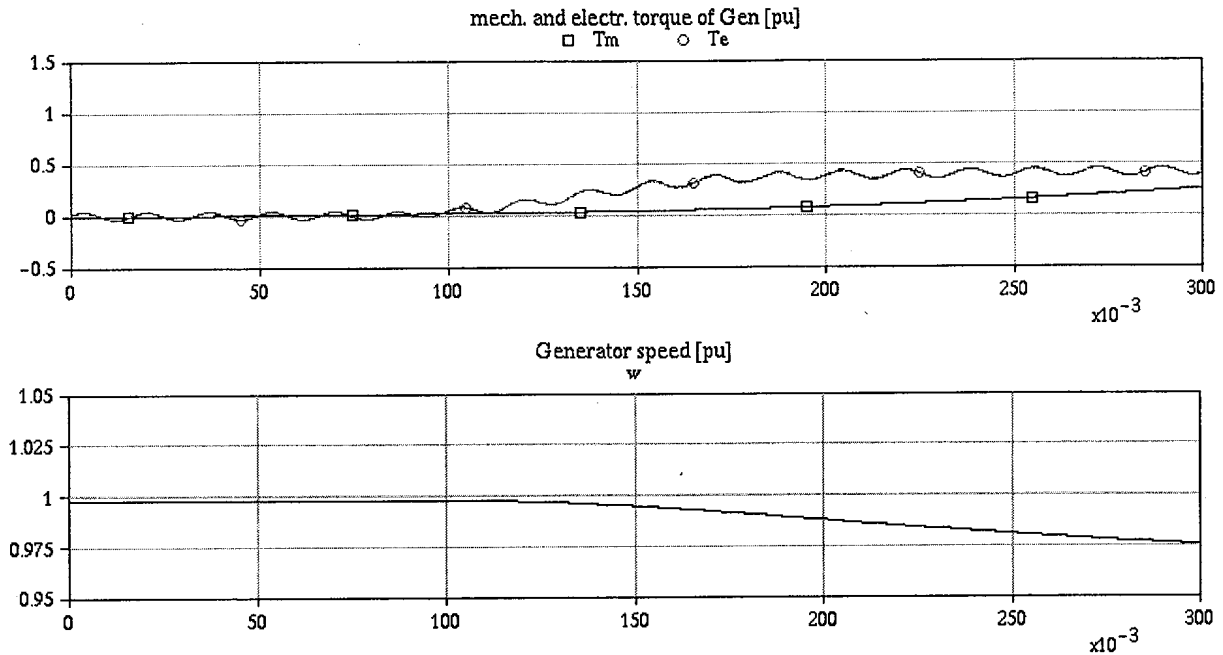


Figure E-8
RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
symmetrical voltage sag of 0.6 pu,
Take over of Load by Genset

This disclosure was read and understood by me on (date),

Robert C. Schenck
 (Signature of witness)

9/27/00
 (Date of signature)

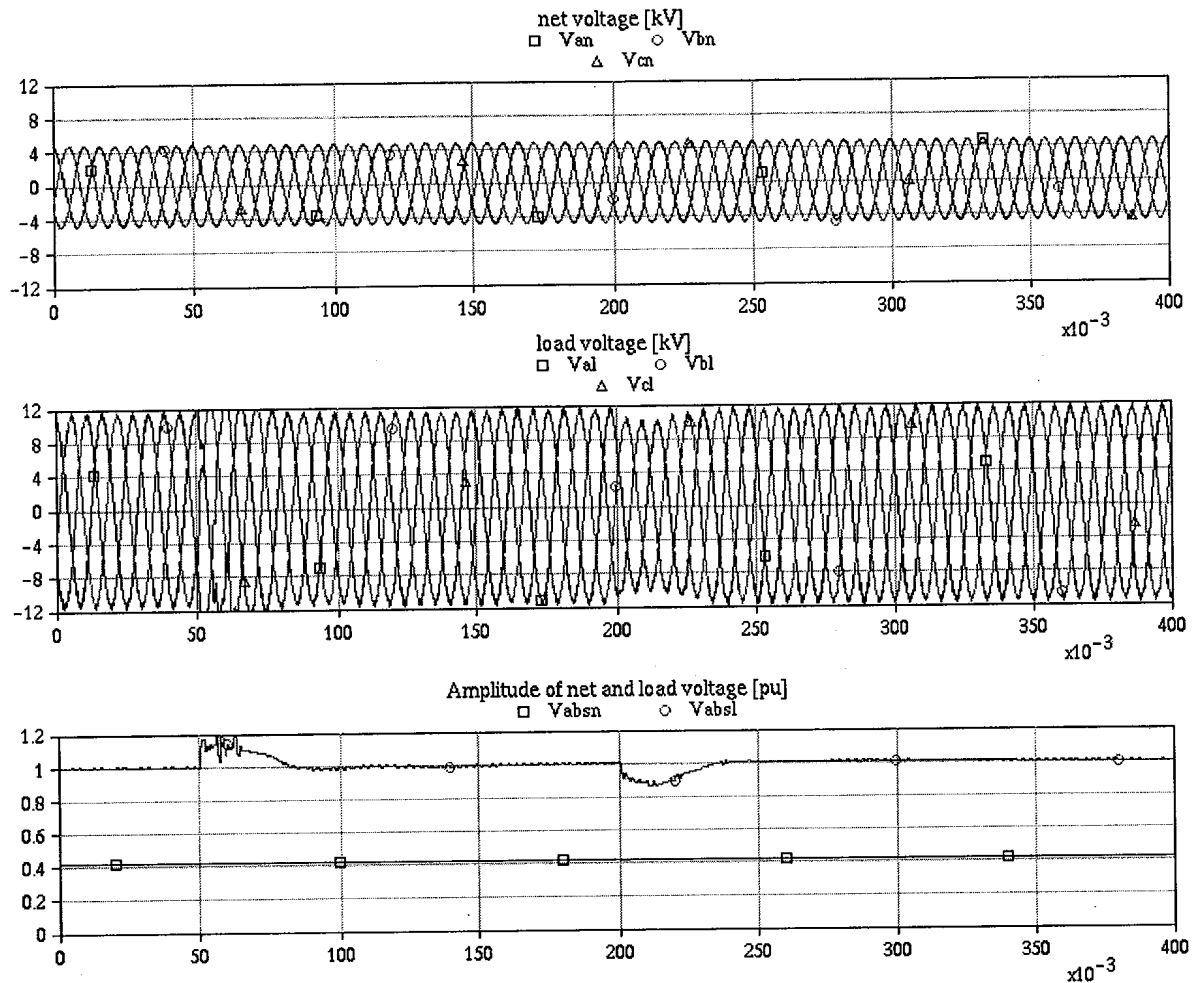


Figure E-9
RL-Load 5 MVA, $pf = 0.7$, Motor-Load 1 MVA, $pf = 0.87$,
symmetrical voltage sag of 0.6 pu,
Switch off and on of RL-Load

This disclosure was read and understood by me on (date).

Robert B. Schaefer
 (Signature of witness)

9/27/00
 (Date of signature)

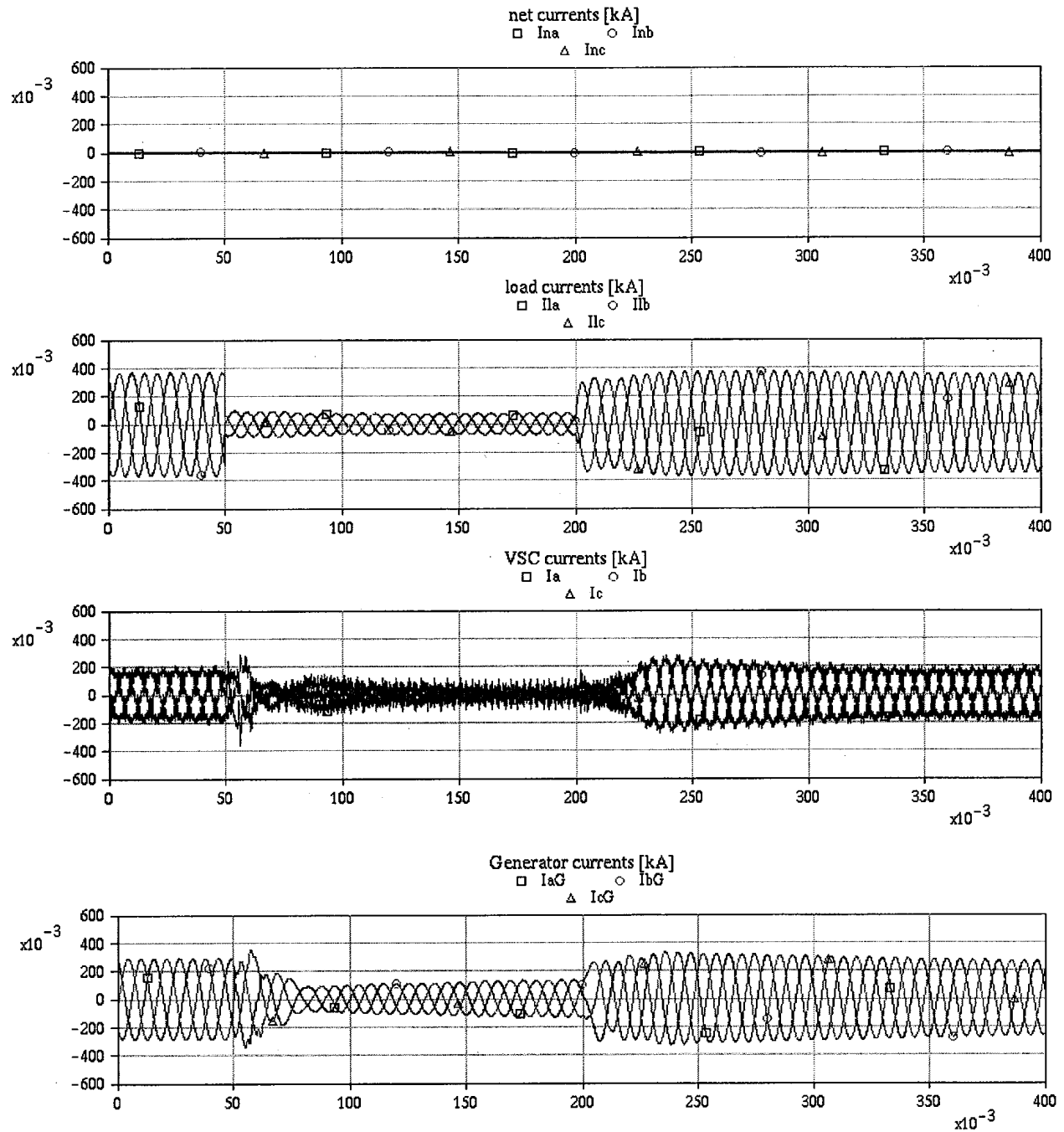


Figure E-10

RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
symmetrical voltage sag of 0.6 pu,
Switch off and on of RL-Load

This disclosure was read and understood by me on (date),
Robert B. Schenk 9/27/00
 (Signature of witness) (Date of signature)

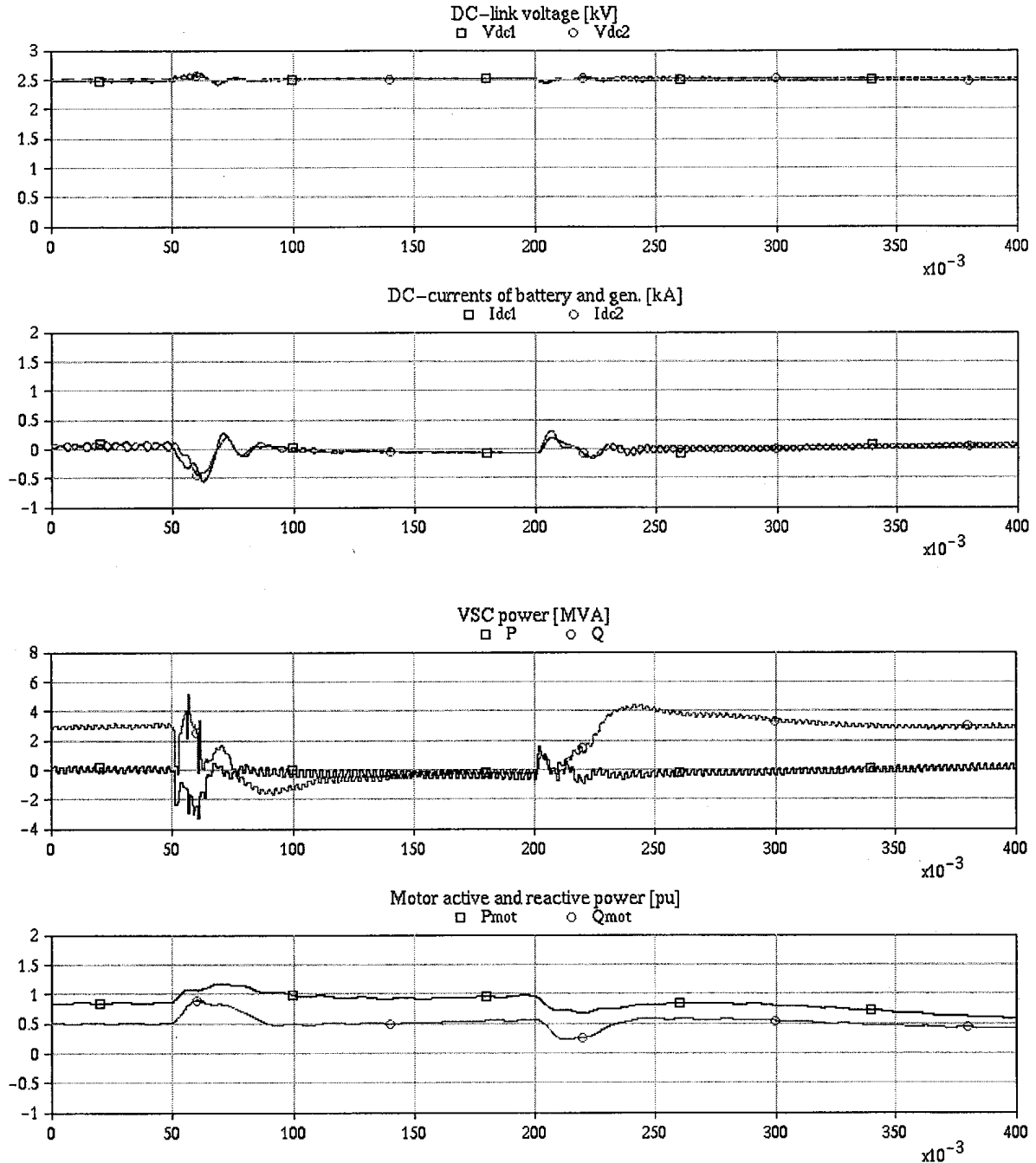


Figure E-11
 RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
 symmetrical voltage sag of 0.6 pu,
 Switch off and on of RL-Load

This disclosure was read and understood by me on (date).

Robert B. Schuele
 (Signature of witness)

9/27/00
 (Date of signature)

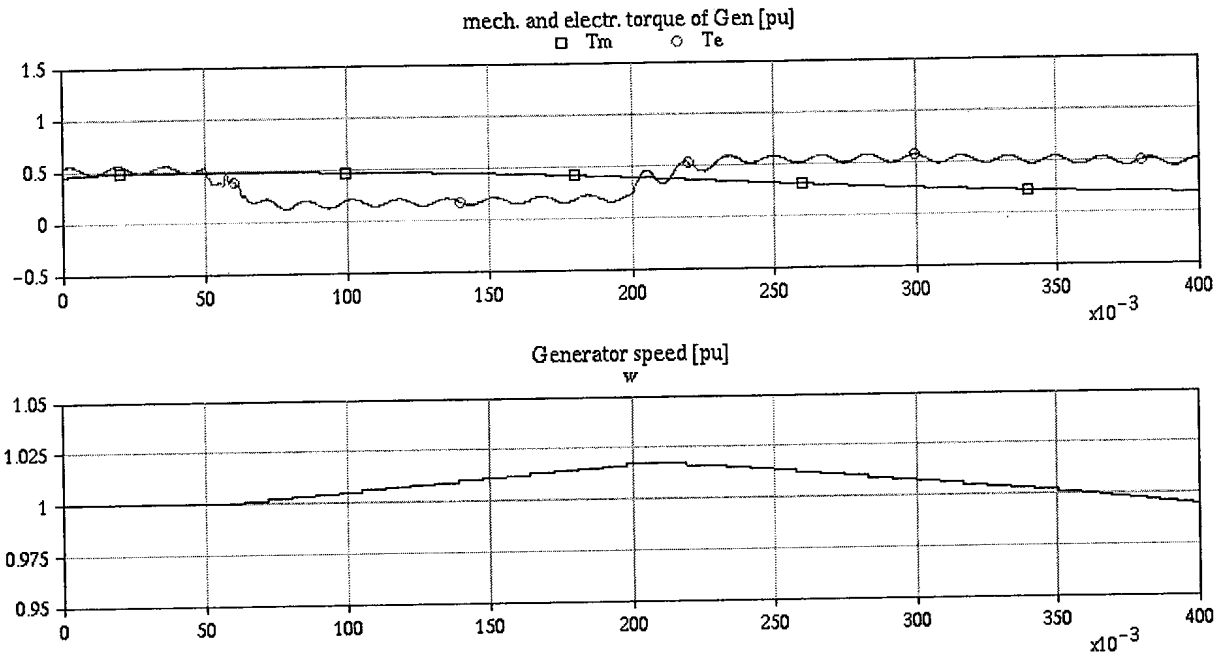


Figure E-12
RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
symmetrical voltage sag of 0.6 pu,
Switch off and on of RL-Load

This disclosure was read and understood by me on (date).
Robert B. Schuch 9/27/00
 (Signature of witness) (Date of signature)

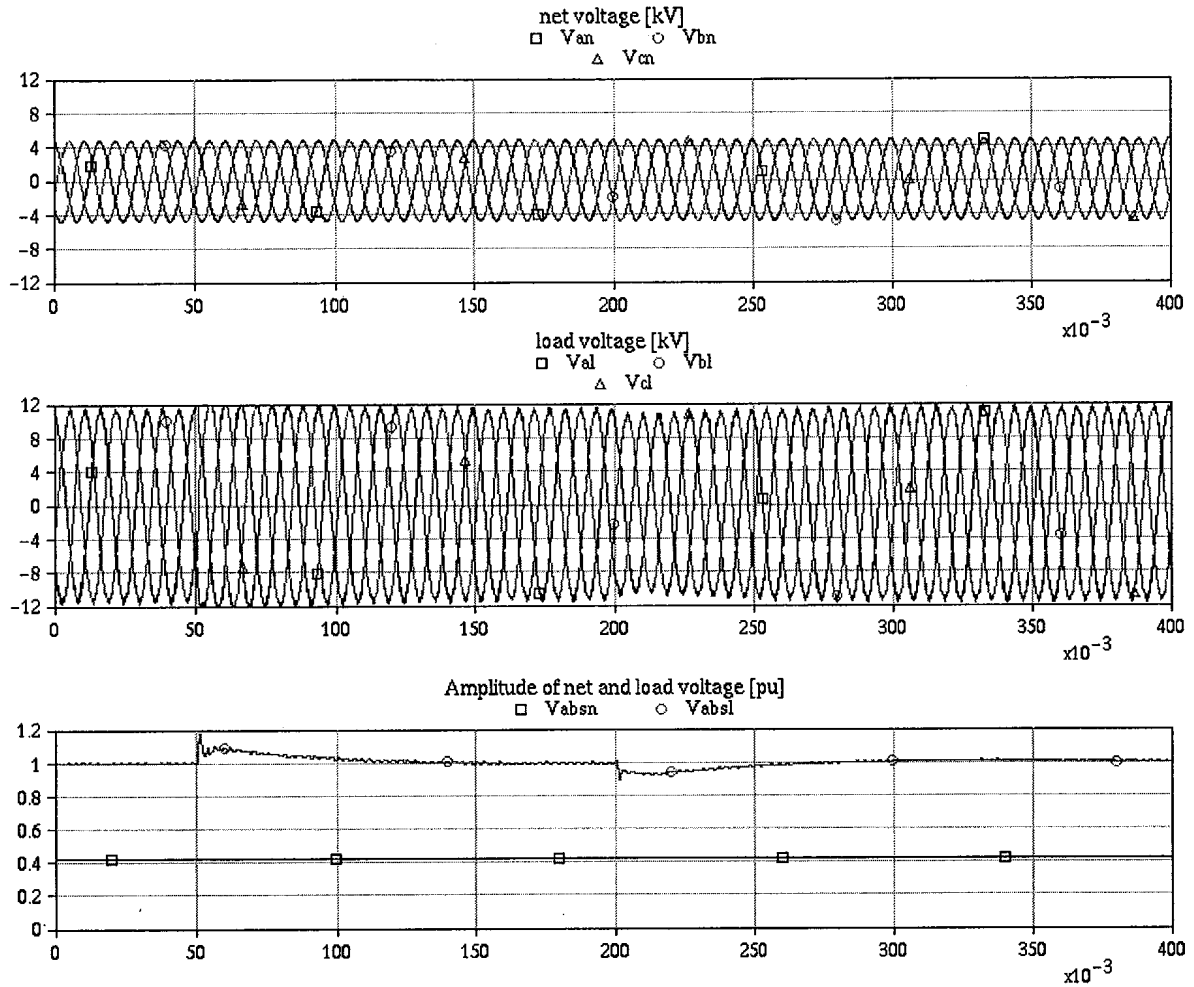


Figure E-13
RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
symmetrical voltage sag of 0.6 pu,
Switch off and on of RL-Load

This disclosure was read and understood by me on (date).

Robert B. Schuck
 (Signature of witness)

9/27/00
 (Date of signature)

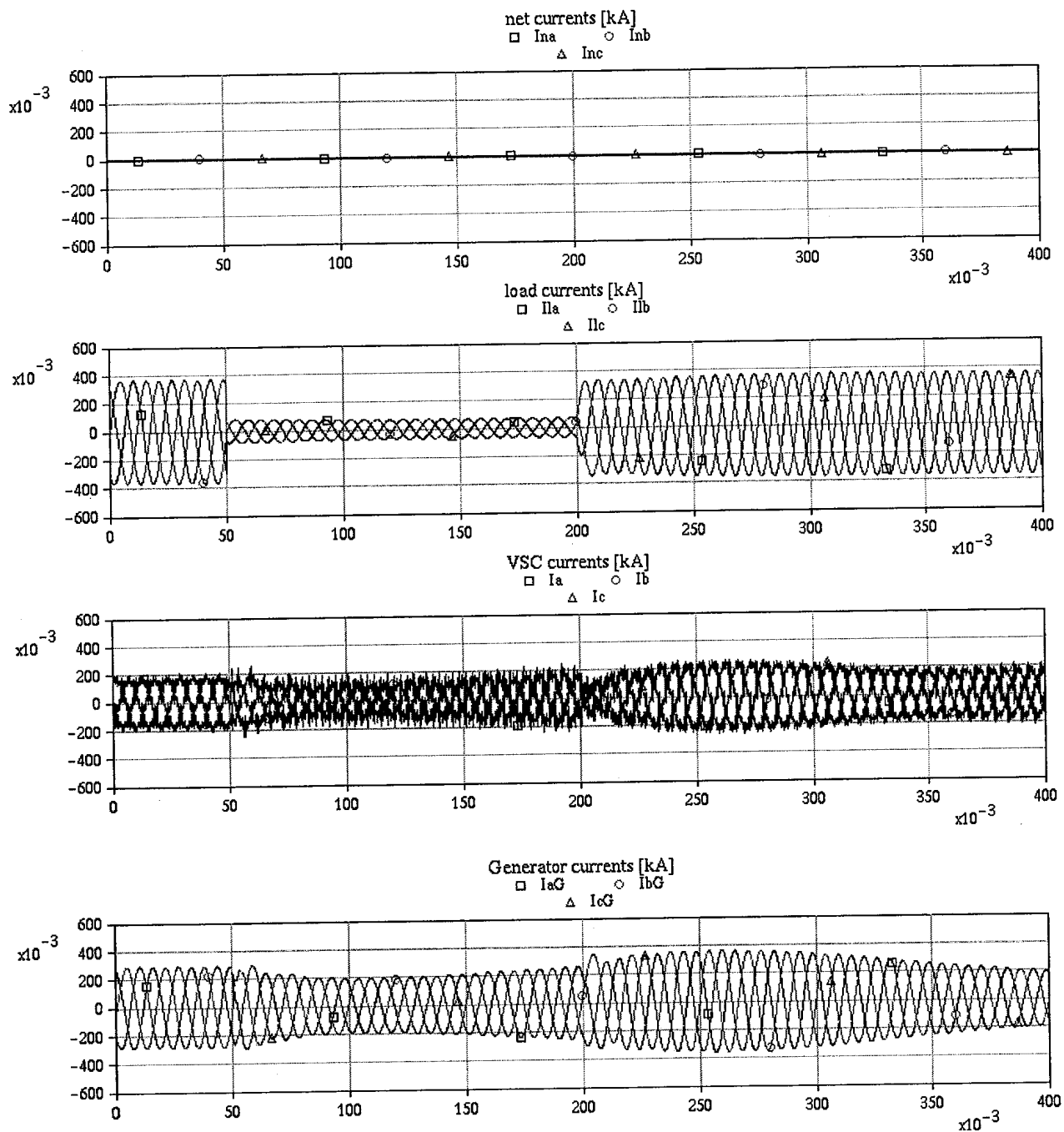


Figure E-14
 RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
 symmetrical voltage sag of 0.6 pu,
 Switch off and on of RL-Load

This disclosure was read and understood by me on (date).

Robert G. McLaughlin
 (Signature of witness)

9/27/00
 (Date of signature)

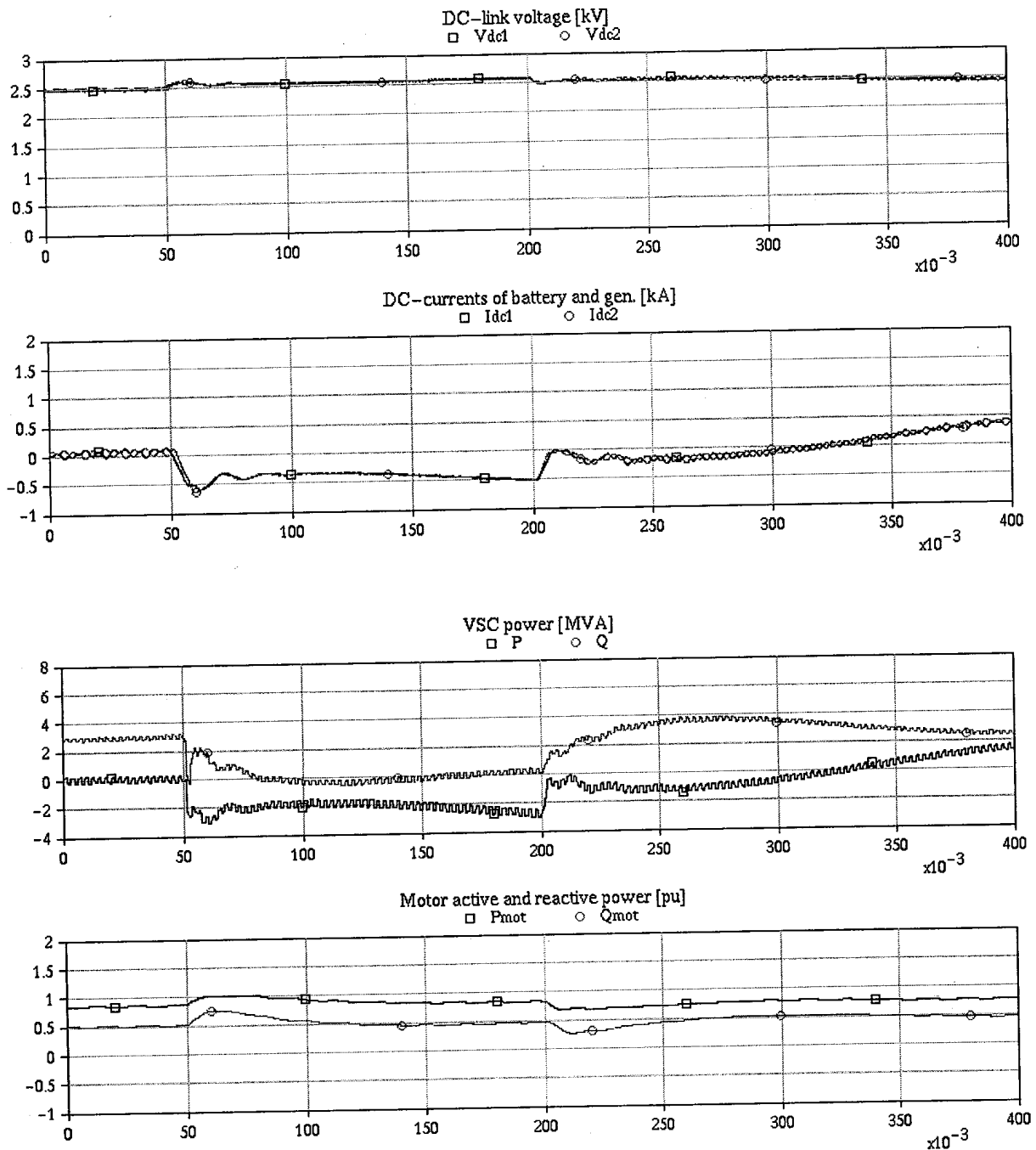


Figure E-15
RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
symmetrical voltage sag of 0.6 pu,
Switch off and on of RL-Load

This disclosure was read and understood by me on (date).
Robert B. Schenk 9/27/00
 (Signature of witness) (Date of signature)

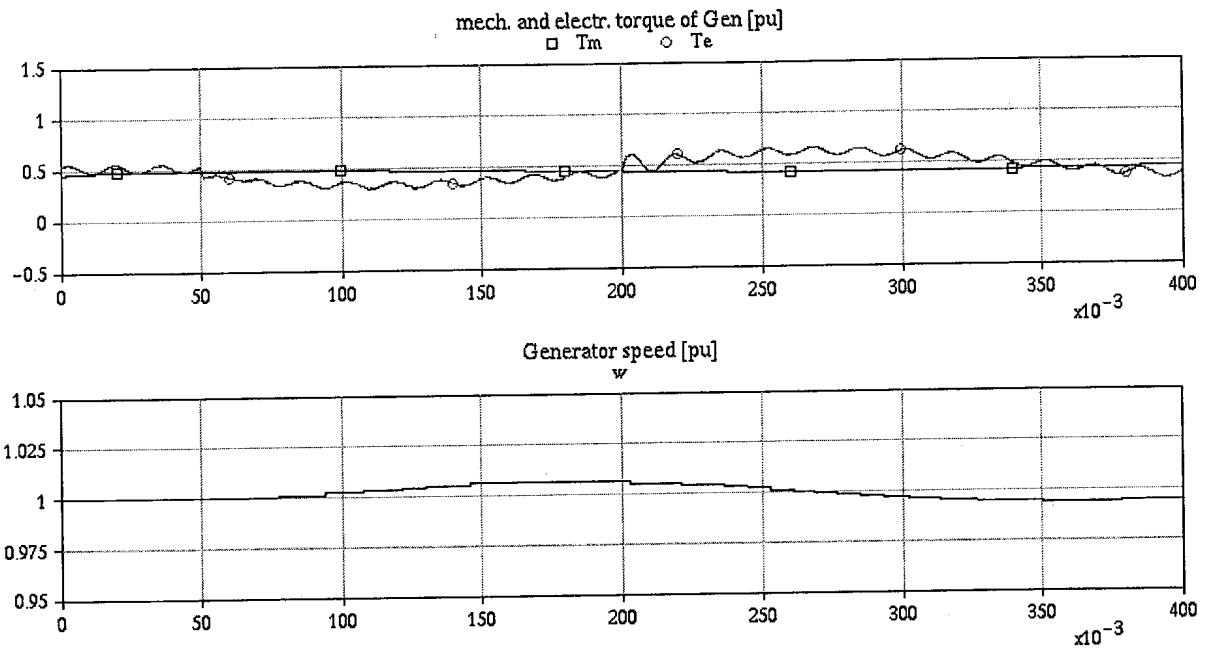


Figure E-16
RL-Load 5 MVA, pf = 0.7, Motor-Load 1 MVA, pf = 0.87,
symmetrical voltage sag of 0.6 pu,
Switch off and on of RL-Load

This disclosure was read and understood by me on (date).

Robert P. Schumaker
 (Signature of witness)

9/27/00
 (Date of signature)

7. Signatures:

Steven Eckroad
Steven Eckroad

10/10/2000
Date

Franz-Joseph Unterlab
Franz-Joseph Unterlab

3/X/00
Date

Martin Hilscher
Martin Hilscher

5.10.00
Date

Hans-Christian Dorn
Hans-Christian Dorn

5.10.00
Date